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ABNORMALITIES IN THE FRUITING HABITS OF OPUNTIAS

By David Griffiths

There have appeared recently an article by Professor Toumey,* which was reviewed by Dr. Harris,† and a note by Dr. Cannon,‡ depicting certain abnormalities found in the fruiting habits of the genus *Opuntia*, Professor Toumey's brochure using these abnormalities to prove the caulome origin of the fruit and Dr. Cannon's simply to record an observation upon a single specimen. Besides the above there is much literature upon this subject, reference to which need not be made here, inasmuch as Mr. Harris quotes a considerable part of it in the above review. There is, however, more to be said upon this subject and it is my object to record some observations and investigations which have been made during the past five years, with little attempt, however, at generalization except to show an apparent relation between sterility of fruit and its assumption of the character of the stem.

To me the strongest evidence of the caulome nature of the fruit is to be found in its leaves subtending pulvini which there is strong evidence for considering modified branches. In a few species there is not only a development of spines and spicules from the pulvini for a number of years after the maturity of the joint but also a distinct development of the tissue of the pulvinus itself into a columnar structure (modified stem) sometimes an inch long. These structures develop gradually for ten years or

* Bull. Torrey Club 32 : 235. 1905.
† Bull. Torrey Club 32 : 531. 1905.
‡ Torreya 5 : 216. 1905.

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more in at least one species and nearly cover the old trunks with the tightly appressed, curved and twisted cylinders completely covered with spicules. If then we find these same pulvini, subtended by leaves, upon the fruit, we can scarcely produce stronger evidence of its caulome nature.

Upon the plains east of San Luis Potosi, Mexico, there are very extensive thickets of *Opuntia Kleiniae*, one of the *tasajillos* of the Mexicans. The plant is exceptionally abundant in the foothills and surrounding the bases of the numerous lone peaks and ridges which are found upon the plains detached from the main mountain range. It is associated with the maguey, mesquite, and other typically desert plants. It presents two strikingly different aspects — indeed they are so different as to make one doubt their identity, were it not for an exceptional plant in which the two extremes are combined in one individual. Simply a variation in the form of plants of the same botanical species gives no great concern, but when as in this case the difference in form is coupled with a radical difference in the fertility of the fruits, the variation has an added interest.

The form of the plant which we shall assume to be typical is the most common one to be found in the general region. It is that form described in the books and is an open-branching plant three or four feet high. It has two forms of branches, one easily separable and relatively short, while the other is longer as a rule, possesses stronger and longer spines, and is firmly attached to the parent plant. Its fruits when mature are always bright red and *sparingly* proliferous.

The other form, while somewhat less abundant in the general region, is even more conspicuous in certain localities upon the plains. It has a more congested habit of growth, a much larger number of the short, easily separable reproductive branches, and its fruits are often entirely green, although they are also often red or with simply a blush of red, and they are *exceedingly* proliferous and produce no fertile seed.

In both forms and in many other species of the Cactaceae the fruits put forth a vegetative growth and develop into new plants whenever they come in contact with the ground. These fruits,

so far as one can see, develop just as readily and are just as easily separable from the plant as the joints themselves, whose main function appears to be vegetative reproduction, and this development of the fruit is itself a purely vegetative reproduction, for it is from the areoles and not from the seed that the new plant springs. Both forms also produce besides the ordinary short cylindrical branches almost perfectly globular ones. These are much more numerous upon the congested form. These globular branches differ in no way from many of the green fruits of the proliferous form, except that the fruits have borne flowers and have the scar of it left at their apices. Neither contain seed but there is invariably a rudiment of a seed-cavity in the fruits but none of course in the branches.

The chief thing to be noted here is that we have one form of the plant with an open-branching habit producing some fertile seed and comparatively few vegetative branches; and the other having lost its seed-producing habit, has modified and increased its facilities for vegetative reproduction at least ten-fold. In no case have I been able to find seed in the proliferous form. Fruits without fertile seed are common in the fertile form also and seldom is there a full quota of fertile ones produced even here.

To test still further the correlation between sterility and increase in vegetative facilities of reproduction, an attempt was made to discover whether the few proliferous fruits of the fertile form were more likely to be sterile than the non-proliferous fruits upon the same plants. An examination was made of a number of proliferous and non-proliferous fruits upon two typical plants of the fertile form with the following results. Of course, many seeds were found with almost perfect shells but having aborted embryos. Where there was any doubt, the seeds were cut open and examined. Usually no dissection was necessary. Five proliferous fruits from each plant were selected and both that attached to the stem and the one growing from it were examined.

The ten proximal fruits contained fertile seed as follows: 3, 0, 0, 0, 4, 4, 1, 0, 3, 2. The ten distal ones contained fertile seed as follows: 1, 0, 10, 0, 0, 0, 0, 4, 0, 1.

An examination was next made of fruits from the same plants giving rise to branches but not to fruits. They showed fertile seed as follows : 0, 0, 3, 4, 4, 4, 0, 5, 6, 8, 1, 3.

Again another examination of normal fruits bearing neither fruits nor branches was made, with the following results : 4, 8, 0, 9, 9, 4, 10, 6, 0, 4, 6, 10, 8, 3, 5.

The above figures are very suggestive but nothing more than that. At least a hundred times more data are necessary to enable one to draw conclusions. But they represent all the data that limited time could secure. The tunas which had been depended upon for food and water for about ten hours failed to satisfy longer, necessitating a postponement of the investigation.

To summarize we might tabulate as follows :

1. The proliferous form of the plant is sterile, so far as I have been able to determine, absolutely.

2. Fertile seed in fruits giving rise to other fruits average 1.7.

3. Fertile seed in fruits giving rise to vegetative branches average 3.6.

4. Fertile seed in non-proliferous fruit average 5.7.

Similar observations might be made upon *O. leptocaulis*, a closely related plant of very similar habit.

The simulating of the stem by the fruit as it loses its fertility is very evident in *Opuntia fulgida*. Normally, the fruit of this species is spineless or, at most, bears only a few fugacious, hair-like, unsheathed spines in the normal fertile specimens. In many cases, however, certain plants will be found in which the fruit bears a goodly proportion of sheathed spines like those of the stem. Experience shows that these spiny-fruited forms bear much fewer fertile seeds than those which do not bear spines. It is equally apparent that it is in the drier situations that sterility occurs and that spines develop on the fruits when they are two to four or five years old, while there may be no evidence of them the first year. For the benefit of those not familiar with *O. fulgida*, it should be stated that the fruit is proliferous, one developing from another until there is a branched, pendant bunch, in some cases a foot long, remaining attached to the plant for a number of years. It is the proximal ones of the bunch which

show most pronounced spines. An experiment which might throw a great deal of light upon the influence of drought conditions upon the sterility of the fruit in this species ought to be undertaken. Cuttings from a plant which in nature is nearly sterile should be grown under artificial irrigation. With suitable checks the influence of drought upon sterile conditions might be shown. The influence of this factor in the lack of seed-production in cultivated and other crops of course is well known but we have here an entirely different condition of things. This is not a case of temporary lack of seed-production caused by temporarily abnormal conditions but apparently at least habitual sterility brought about in a given perennial species growing in a certain situation and not taking place in the same species in another situation but a few miles removed, and this sterility accompanied by a simulation on the part of the fruit of one or more of the caulome characteristics. My observations indicate that it is on the desert mesas that the largest proportion of the sterile-fruited forms occurs in this species and that fruits of those plants growing in the foothills are more likely to be spineless.

There is probably no species of *Opuntia* in which the fruit simulates the stem more closely than in *O. subulata*. In plantations which have been examined in this country fruits with no constriction between them and the stem were the rule rather than the exception. In other words, the fruit in a very large percentage of cases was imbedded in the end of a branch.* Proliferous ones are also very common. Such features are equally true of *O. cylindrica* and the imbedding of the fruit in the end of a branch is not at all rare in *O. spinosior*, *O. versicolor* and *O. arborescens*. It is apparently more common in these species under cultivation.

The union of fruit and joint or the imbedding of the fruit in a joint is very common in the Platyopuntias and apparently it is more abundant in some species than in others. In a spineless form of *O. chlorotica* of which we have seen no mention in literature, the phenomenon is so common in some localities in southern

* See also Schumann's Gesamtbeschreibung d. Kakt. 681. *f. 103.* 1899.

Arizona that I, for a time, considered this the normal condition of the plant. In all cases observed the fruit-joint is small, very uniform and regular and has the same form as the normal joint. In 1903 a single plant of this variety in the Celero Mountains produced 18 of these fruit-joint structures and no normal fruits. In 1905 the same plant produced not less than 50 perfectly normal fruits with no abnormals. These were carefully examined but no insect or other injury was found to which the condition could be attributed, but I am inclined to look for some mechanical explanation for the phenomenon. This is the only species in which regular abnormal structures of this kind have been observed. Usually the fruit simply appears to expand on one side or the other into a joint-like structure with no regularity or symmetry. Such abnormalities are very common in the Mexican cultivated forms such as *Nopal amarillo*, *naranchado*, *camueso*, *tcco*, etc.

A very peculiar set of fruit modifications is brought about by insect depredations. A dipterous insect which deposits its egg in the ovary of *O. Lindheimeri* invariably causes a reversion to the vegetative condition. The ovules become atrophied, the funiculi (?) developing into short, cylindrical, curved and twisted structures and the ovary remaining green. So far does the ovary change to the vegetative condition that it very commonly gives rise to joints so that we have joints developing from imperfect but good-sized fruits. Such growths have been very common in southern Texas for the past two years. Such structures, however, are never incorporated as a permanent part of the plant in this species but drop off early the following summer after the insects have matured.

A similar (possibly the same) insect affects the ovaries of *O. versicolor* in much the same way but the growth of joints from the ovaries is somewhat rare. Frequently in this, less frequently in *O. Lindheimeri* and commonly in other Cylindropuntias there is a tendency for the pistil to begin a reversion into the vegetative state and remain, so far as its hollow base is concerned, upon the ovary until the latter drops off of the plant. In some cases the base of the pistil actually enlarges slightly, *i. e.*, starts

to grow. When this structure is fully grown the ovary usually has a similar structure to that described for *O. Lindheimeri* and in addition is surmounted by this butt of a hollow style.

Perhaps the most peculiar abnormality of all, more rarely met with, is that in which the tissues of the joint simulate portions of the fruit. A few joints of the cochineal pear (*Nopalea cochinillifera*) were found the past season wherein a portion of the base of several joints had turned to the color of the fruit. Examination showed that the texture as well as the flavor was exactly that of the rind of the mature fruit. There were no fruits produced by any of these joints. The abnormal red portion was a little swollen and more prominent than the remainder, but further than this, there was no abnormality except that the vascular system for some reason was slightly knotted. It is not at all uncommon to find joints or portions of joints of *O. Kleiniae* or *O. leptocaulis* simulating their fruits in color. The red coloration in these species may occur at the proximal, distal or central portion or may take in the entire joint. A change in the tissue also accompanies the change of color but these joints often become incorporated as a permanent part of the plant body. It is not at all uncommon to find portions of the joints of *O. laevis*, and other Platyopuntias, adjacent to the fruits becoming somewhat changed when the latter ripens. Sometimes the tissues immediately surrounding the vascular bundles entering the fruits may simulate the color of the fruit for an inch below the areole while at other times the whole areolar region is colored red.

WASHINGTON, D. C.

CRATAEGUS OF DUTCHESS COUNTY, NEW YORK*

BY W. W. EGGLESTON

With but little time for exploring in 1905, I had two things in mind in regard to my *Crataegus* problem. The first was to know the form in the field which Dr. Britton had considered nearest *Crataegus coccinea* L., and the second to cover as much unexplored territory north of the city as possible.

* Read before the Torrey Botanical Club, February 28, 1906.